Attorney Docket No.: 10541-1927

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art Unit: 3681

Examiner: Roger L. Pang

Inventors: Kahlon, et al.

Serial No.: 10/731,936

Filing Date: December 10, 2003

Title: ISA ENGINE START-UP STRATEGY

DECLARATION OF NING LIU UNDER 37 C.F.R. §1.131

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Ning Liu hereby declares that:

1. I am an inventor of the invention as claimed and described in the above-identified application.

2. I conceived said invention in the United States prior to March 1, 2002, as evidenced by the January 24, 2001, creation date of the Invention Disclosure form including the written description and figures in the "Attachments" section of the Invention Disclosure form. The Invention Disclosure form being attached hereto as Exhibit A

3. That said invention was diligently worked on from a date prior to March 1, 2002 until the filing of the parent application 6,752,741 on May 31, 2002, from which the instant application receives priority.

4. All statements made herein of my own knowledge are true and that all

statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statement may jeopardize the validity of the above-identified application, and any patent issuing thereon or any patent to which this declaration is direction.

Dated: 1/5/2004

Ning Liu

Online Invention Disclosure: View Invention Disclosure

Inv. Discl. Docket No:	V201-0071
Creation Date:	1/24/01
Approval to submit was given by:	GKAHLON: 21-NOV-00 JKLOCINS: 24-JAN-01 NLIU2: 24-JAN-01 SSWALES: 24-JAN-01

Section 1: INVENTION DESCRIPTION

Title of Invention:	ISA START UP STRATEGY
Patent Evaluation Committee:	$VNTO
CPSC Code:	03.00.00
Originating Country Code:	US
Related Disclosure(s):	None

Section 2: PROBLEM & SOLUTION

Description or Comments:	Please see the attached file.
Attachment:	See Section:9 ATTACHMENTS

Section 3: PRIOR ART

Description or Comments:	Toyota Prius and Honda Insight.
Attachment:	See Section:9 ATTACHMENTS

Section 4: NEW TECHNOLOGY

Description or Comments:	
Attachment:	See Section:9 ATTACHMENTS

Section 5: DETAILED DESCRIPTION

Description or Comments:	The detailed strategy flow chart is included.
Attachment:	See Section:9 ATTACHMENTS

Section 6: DATES

Record(s) of Completion:	The file for patent description was created on 11/4/99 on Shawn Swales computer.
Date of Completion:	1/2/01
First Production Use: [Model and Date]	Any OEM as customer: MY 2004

Section 7: CATEGORY QUESTIONS

Invention Category: Electrical

Category Questions do not exist or not answered.

Section 8: MISCELLANEOUS ITEMS

Is it a Government Contract?:	No
If yes, Government Contract Number:	
Identify a government agreement, partnership, consortium, or other company involved with conception or first building of the invention:	
If disclosed to non-Company personnel, identify recipient and date:	
Identify potential licensing oppurtunities within and, as appropriate, outside the auto industry. If possible, name potential companies that should be contacted:	All OEM interested in developing Hybrids.

Section 9: ATTACHMENTS

File Name Click on File Name to view and print it.	Description
25056Problem_And_Solution.doc	Your original attachment file : Problemandsolutionstartupstartegy.doc was renamed.
25056Detail_Description.doc	Your original attachment file : Startupstrategy.doc was renamed.

Section 10: INVENTORSHIP

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Email Disclosure

Owner: FGTI | Version 1.1 | Last Updated: January 11, 2001

Problem and solution:

The present invention addresses various problems associated with implementing a "start-stop" strategy, in which the engine is shut off for improved fuel economy during some periods in which it would otherwise be at idle, in a vehicle with an conventional automatic transmission with torque converter, and a combined starter-generator. A system diagram and a flow chart of the two strategies are provided in the Detailed Description. Problems and solutions are described below:

"cold" start strategy:

1. Problem: high cranking torque required due to high engine friction under cold conditions drives the size of the motor and the capacity of the electrical system. Solution: (a) begin to bring the motor (but not the engine) up to starting speed when the ignition switch is moved to the run position. This provides some additional time to store kinetic energy in the rotating mass of the rotor and torque converter, which can be delivered rapidly to the engine upon movement of the ignition switch to the "start" position. This provides a rapid perceived start for the driver, and high engine input torque if required, while allowing lower peak motor torque.
2. Problem: Potential for drainage of the cranking battery if the motor continues to crank even though the engine fails to start. Solution: The strategy provides a finite crank time, and lower limits on battery/capacitor state-of-charge, after which the motor will shut down if the engine fails to start, and driver intervention is required to re-initiate cranking.

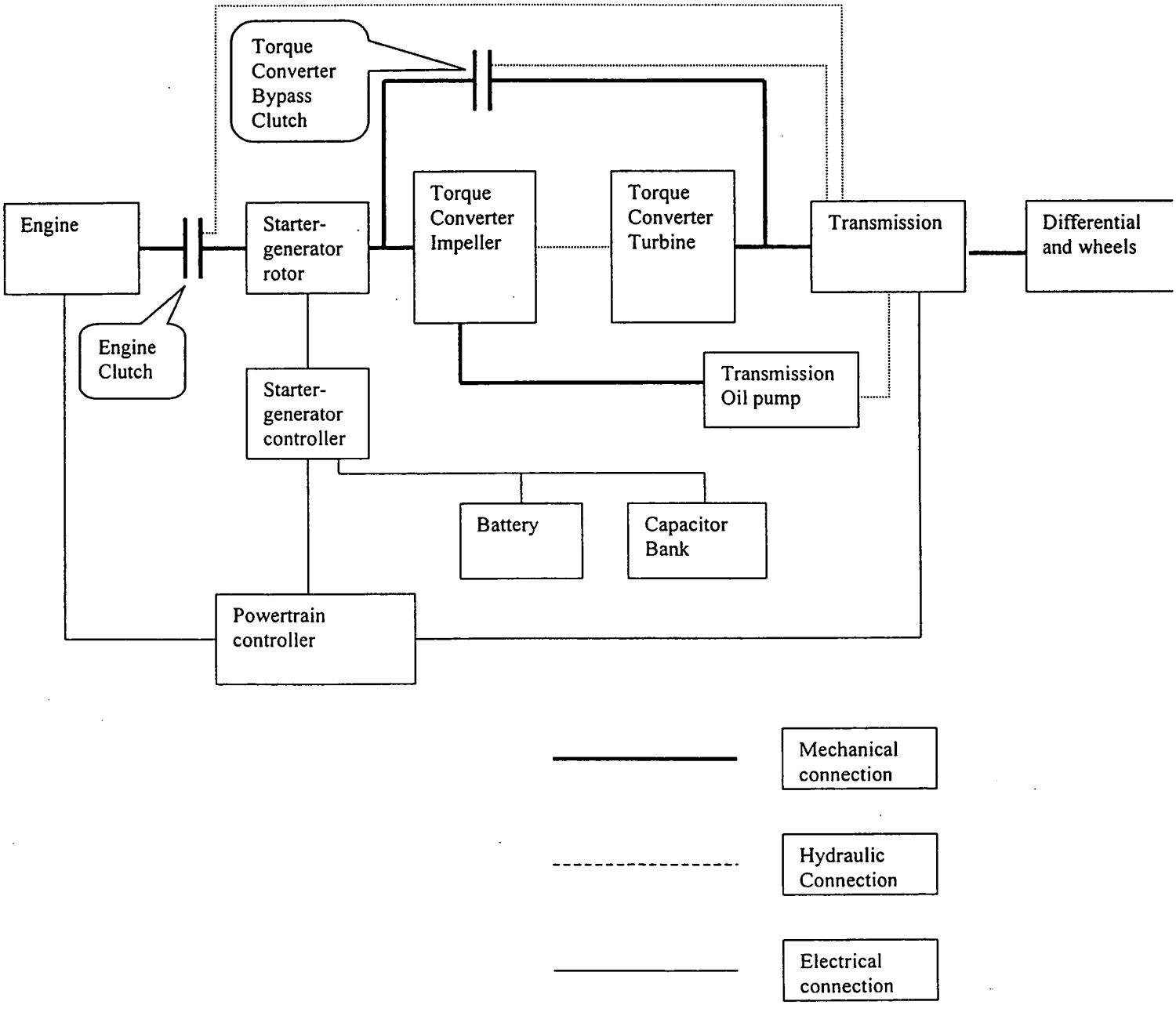
"warm" start-stop strategy:

1. Problem: In a conventional powertrain, the transmission oil pump is driven directly from the engine crankshaft, and so shutting off the engine stops the hydraulic supply to the transmission, allowing clutches and bands to disengage, or an auxiliary transmission pump is needed. Reengagement of these clutches upon vehicle launch produces unpleasant NVH characteristics. Solution: The strategy allows for the engine clutch to be disengaged when the engine is off, such that the motor can drive the transmission pump at sufficient speed to maintain transmission function. At these drive speeds, the stall torque of the converter is typically very low so losses when standing are minimal, yet the transmission remains fully engaged, and a smooth launch can be made upon engine restart, taking advantage of the torque converter's characteristics. Losses can be lowered even further by raising the torque converter's capacity (K) factor at low speed ratios, if necessary. No auxiliary pump is required.
2. Problem: The engine mounting system is typically tuned to resonate well below the idle frequency of the engine. This can produce an unpleasant shake when the engine passes through this frequency upon shutdown. This is acceptable for relatively infrequent driver-commanded shutdowns, but unacceptable for more frequent, automatic shutdowns. Solution: The strategy uses the motor to provide a negative (braking) torque to the engine to move it rapidly through the resonance speed, thereby reducing or eliminating excitation of the resonance and occupant perception of any vibration.
3. Problem: Customer perception of the start-stop function due to time lag associated with cranking the engine. Solution: The strategy uses a brake pedal position (BPP) sensor, or brake line pressure sensor to detect when the driver's foot just begins to release the brake pedal, such that vehicle "creep" torque can be created by the motor, and engine start can be completed, before the brake pedal is fully released. Provision of restart and "creep" torque in this manner also prevents a vehicle being left unattended in "drive" mode. The strategy includes hysteresis to avoid shutdown-restart busy-ness associated with the brake pedal sensor input. The strategy also initiates a restart upon opening of the throttle, regardless of brake position, so the driver can restart early if desired.
4. Problem: Long periods of engine shutdown will yield cool cylinder walls, and exhaust aftertreatment catalysts which will result in high emissions on restart. Solution: The strategy includes a provision for an automatic restart, even in the absence of driver input, if engine or catalyst temperature falls below a threshold value. The temperatures can be sensed directly, or inferred from other data available to the powertrain controller, for example ambient temperature, time, and engine coolant temperature. The automatic restart is prevented if the vehicle's hood has been raised. Note: The strategy shows this as a decision in the flow chart, assuming that the loop time is well below the time required to raise the hood. In the event loop times approach 1 second, this hood condition check will be implemented as an interrupt.

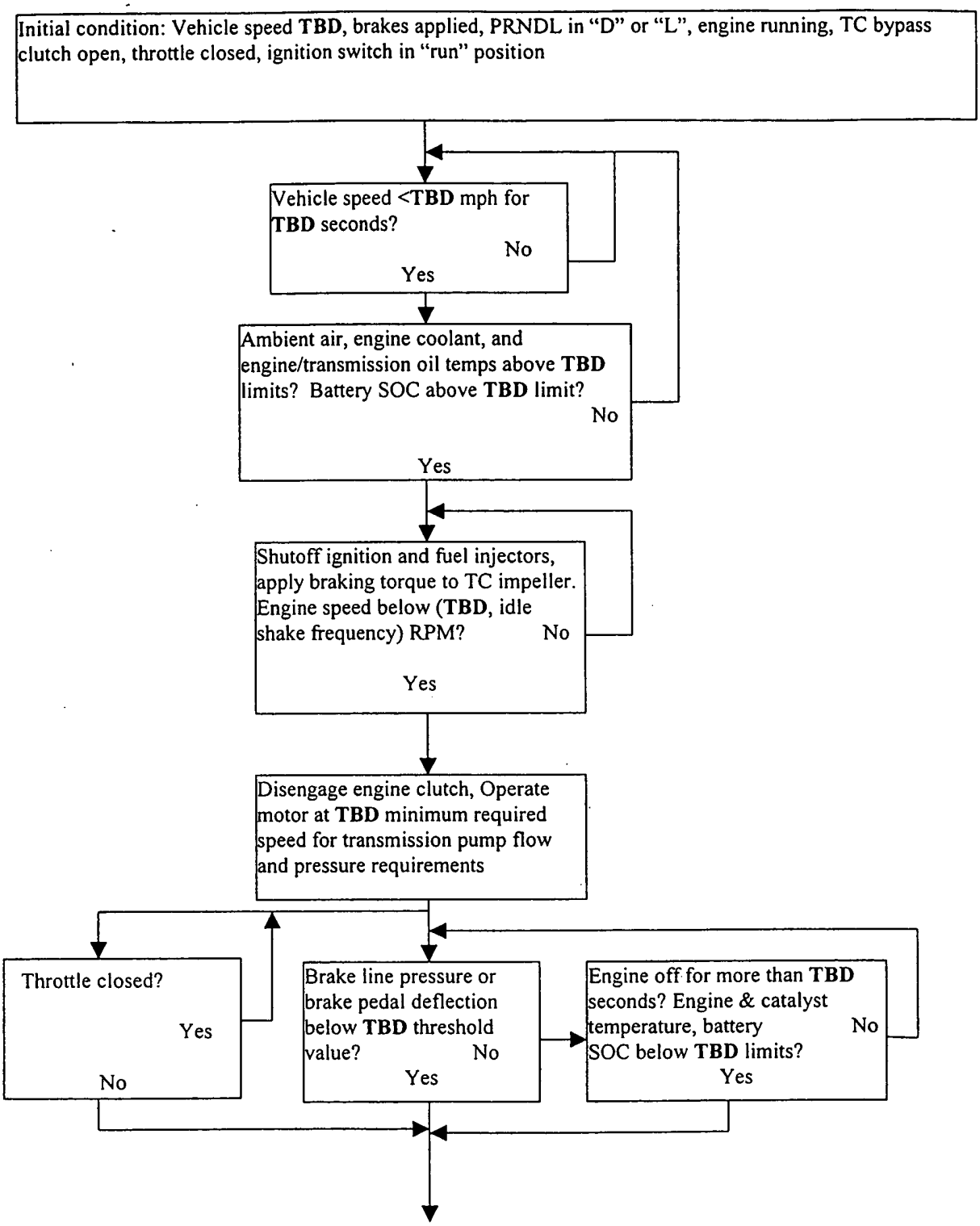
5. Problem: If the engine fails to restart when in start-stop mode, the car is immobilized in traffic. Solution: The strategy provides for detection of this event, and initiates a "limp to curb" mode, where the motor alone provides tractive effort to drive the vehicle, upon throttle input by the driver, such that the vehicle can be maneuvered to a position out of traffic flow.
6. Problem: Certain conditions may make cranking and restart difficult. Solution: The strategy prevents automatic shutdown of the engine when engine and transmission fluid temperature, ambient (outside) temperature, or battery/capacitor state-of-charge values are below threshold values.
7. Problem: Under certain conditions when the vehicle is stopped, the driver may wish to idle the engine due to climate control conditions (heat, A/C, defrosting). Solution: The engine will not automatically shut off if the PRNDL is in "Park". Also, if the engine shuts off in "Drive", and the PRNDL is subsequently moved to "Park", and the ignition switch is not turned off within a specified time limit, the engine will automatically restart.

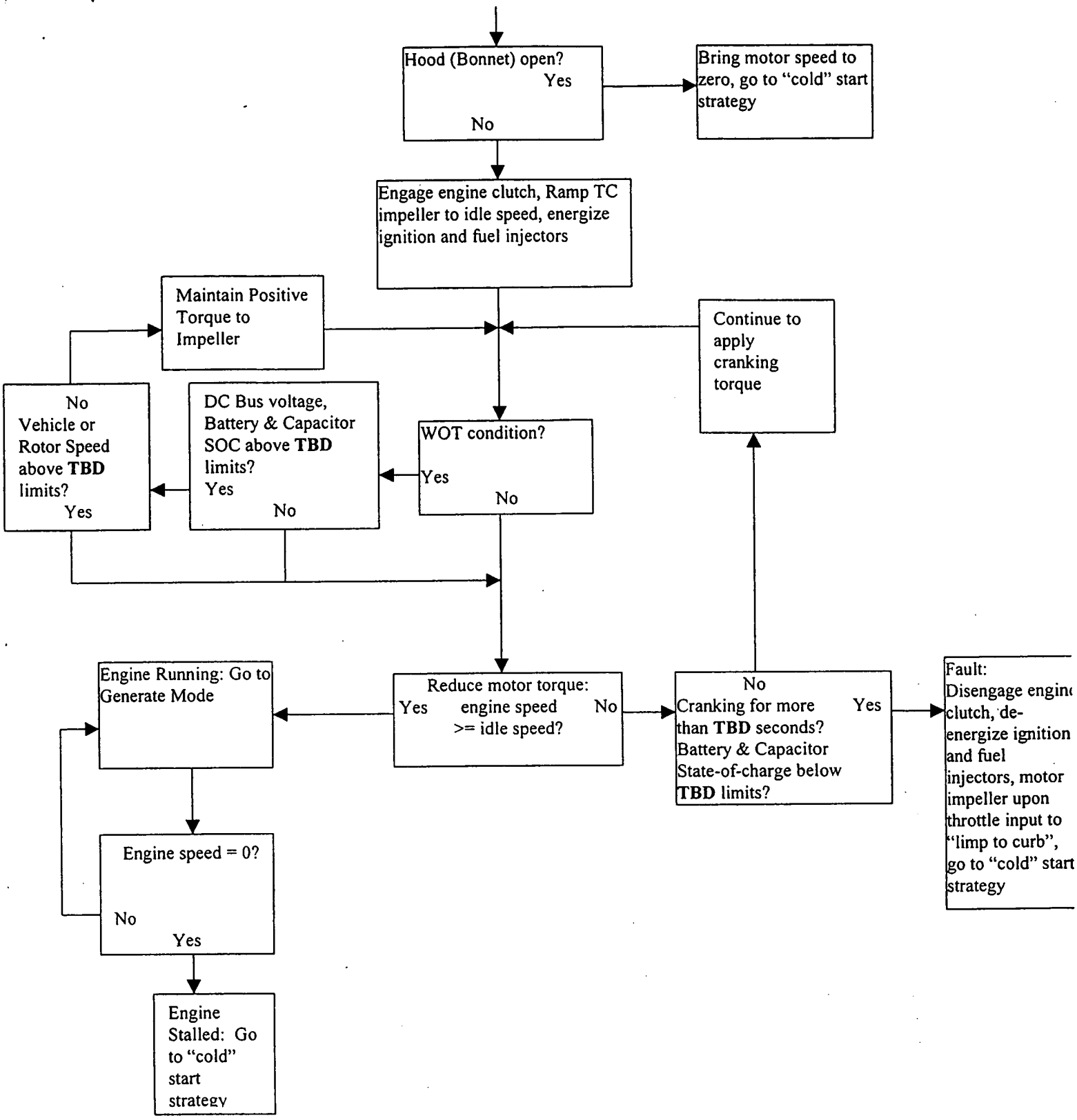
Startup strategy for vehicles equipped with integrated starter-alternator and automatic transmission with torque converter, and clutch between the torque converter impeller and the engine (an "engine clutch"). Separate strategies are employed for the case of a "cold" key-initiated start, and a "warm" or torque-demand initiated start, as in start-stop mode.

System Diagram:



"warm" or torque-demand initiated stop-start:




Hood (Bonnet) open?
Yes
No
Bring motor speed to zero, go to "cold" start strategy
Engage engine clutch, Ramp TC impeller to idle speed, energize ignition and fuel injectors
Maintain Positive Torque to Impeller
Continue to apply cranking torque
No Vehicle or Rotor Speed above TBD limits?
Yes
DC Bus voltage, Battery & Capacitor SOC above TBD limits?
Yes
No
WOT condition?
Yes
No
Engine Running: Go to Generate Mode
Reduce motor torque:
Yes engine speed >= idle speed? No
No Cranking for more than TBD seconds? Battery & Capacitor State-of-charge below TBD limits? Yes
Fault: Disengage engine clutch, de-energize ignition and fuel injectors, motor impeller upon throttle input to "limp to curb", go to "cold" start strategy
Engine speed = 0?
No
Yes
Engine Stalled: Go to "cold" start strategy

"cold", or ignition switch initiated start: